

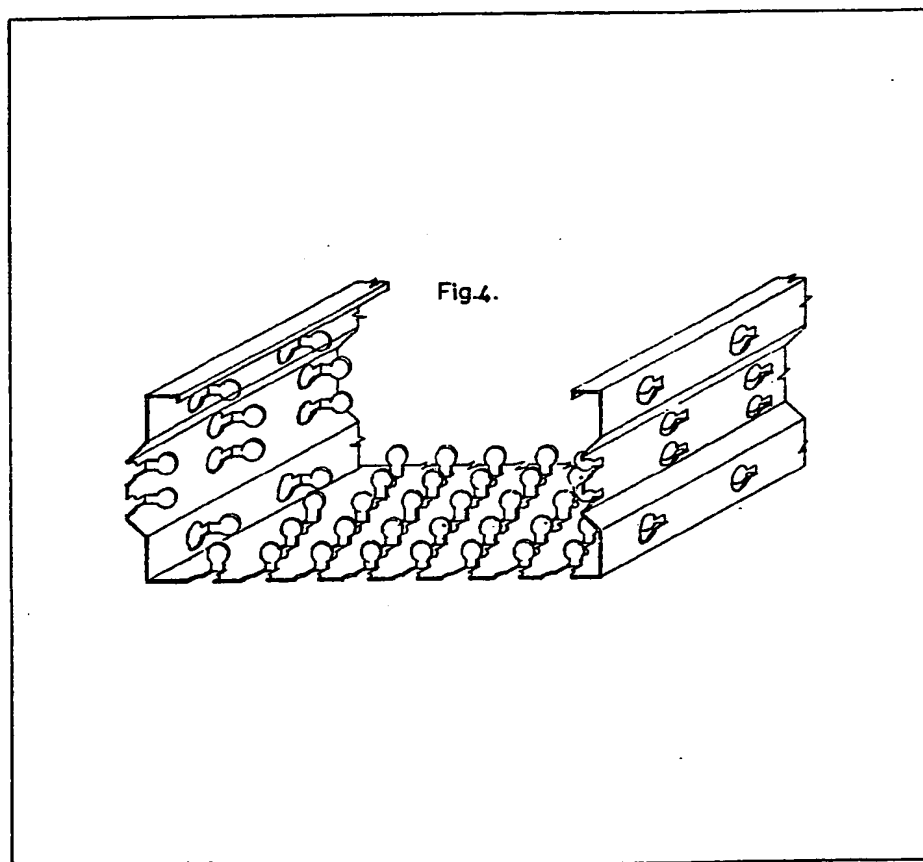
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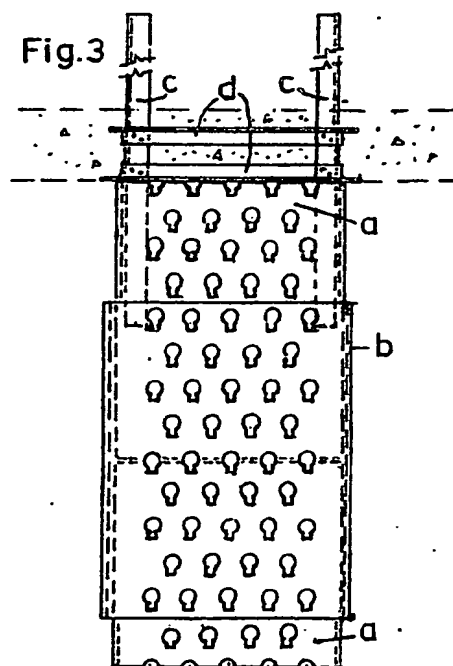
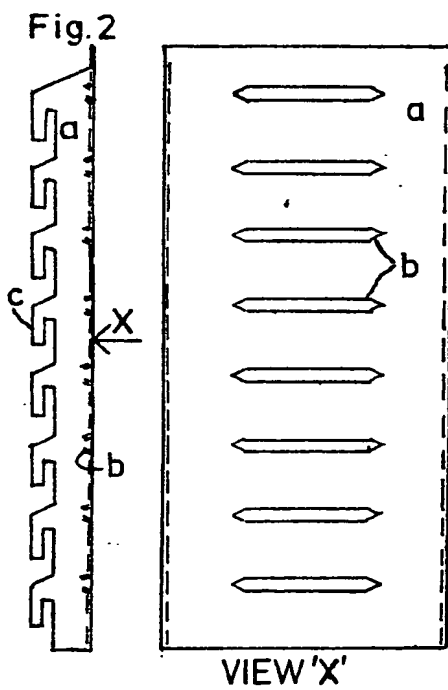
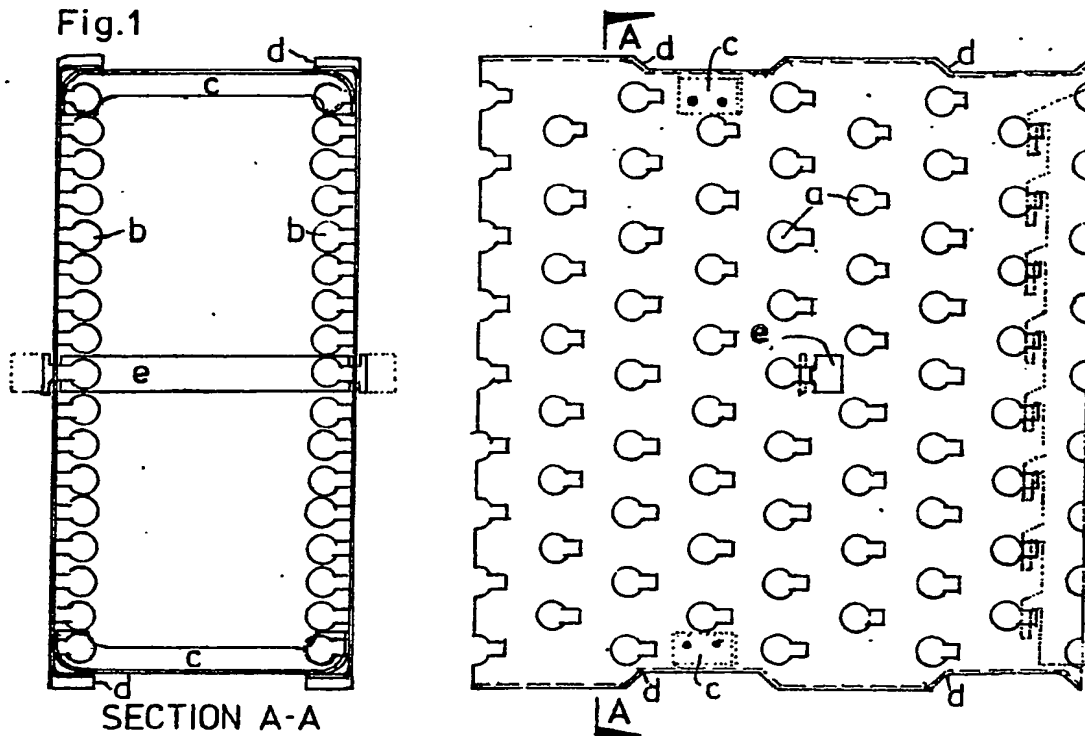
(54) **System of construction or composite structural members with various captive infilling materials**

(57) In this system of construction thin shutters with mechanical in addition to frictional, bonding formations are provided for keying to infilling materials ranging from suitably hardening soils, with or without fibrous content, insulating materials, mortars, to additionally

reinforced concretes for structural members. The densely distributed bonding formations consist of perforations and associated projections with enlarged ends formed by punching or otherwise to form mainly mechanical anchorage in the infilling material and automatic cover to any additional reinforcement. These shutters may be used for the construction of walls, lintels, beams, columns and floors.

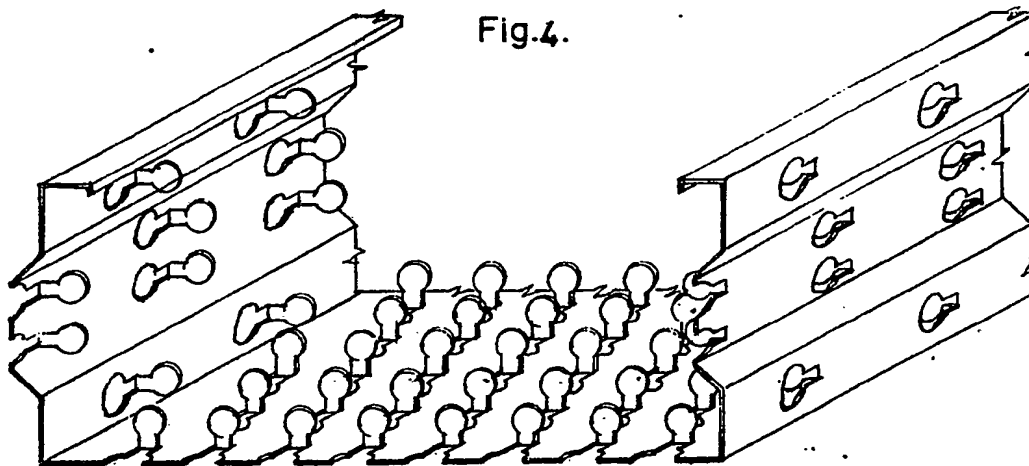


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## SPECIFICATION

### Enhanced bond and captive infill construction system

(hereafter referred to by the acronym — the ENBACIC System)

#### Technical Field and Background

This system is applicable to construction in general and building in particular. The ENBACIC System is intended to replace or supplement brickwork, blockwork, conventional reinforced and prestressed concrete, and standard sections of structural steelwork in the construction of walls, piers, columns, beams, floor slabs and lintels, ties and struts.

#### 15 Principal Features of the Invention

The principal features of the invention are the projecting studs, e.g. Figures 1, 3 and 4, and the formation of densely spaced perforations thus creating enhanced bonding of the container with the infilling material and holding it captive in the containers of various cross-sections, sizes and lengths, and thus forming a new constructional system, or part thereof.

#### Scope

The ENBACIC System consists of preformed containers, forming permanent shutters and reinforcement, hereafter referred to as ENBACIC shutters, which may be made from long thin suitably rustproofed sheets of steel, or other suitable material. The shutters may be densely perforated and the suitably shaped and inwardly projecting studs resulting from the perforation, or otherwise, bond the shutter with a suitable infilling material to form an ENBACIC constructional unit or element.

The infill for the ENBACIC shutter may consist of any suitable material attaining a desired compressive strength, e.g. concrete, lightweight or otherwise; mortars containing, say, waste products such as broken or crushed bricks, blocks, etc.

#### Advantages

The ENBACIC shutters serve as permanent formwork, as well as reinforcement. The perforations facilitate inspection to ensure proper distribution of the filling material, allow the fill to 'breathe', enable plasterwork to adhere, fixings to be fastened etc. The perforations also enable steel rods to be threaded through, if necessary, for other reinforcing and tying purposes. The studs, when embedded in set fill, minimise buckling tendency of the thin shutter walls when in compression, and maximise bond when in tension. In columns and struts the compressive strength of the fill is enhanced by virtue of it being enclosed and held captive by the ENBACIC shutter, thus restraining bursting effects.

The ENBACIC units may be further reinforced with bars etc., as in conventional concrete design.

By virtue of their capacity to resist bending,

direct tension, compression and shearing forces, the ENBACIC units can be used as structural elements which may also be prefabricated.

Considerably larger wall panels than have been possible so far may be constructed of normal cavity wall thickness with brickwork or blockwork.

In hot climates, for temporary accommodation, the ENBACIC shutters can be filled with suitable clays, or 'mud' laced with straw, etc. The ENBACIC System may be particularly suitable for buildings whose walls are required to span over soft spots in the ground, and in earthquake and hurricane zones.

The perforations should be of a size and distribution suitable for a particular infilling material to prevent excessive loss during filling operations. Mechanical vibration of the filling material may be eliminated as inspection through the perforations will reveal deficiencies. Air pockets at the interfaces with the ENBACIC shutter are largely eliminated.

The ENBACIC System may be used by semi-skilled bricklayers and D.I.Y. enthusiasts, under the guidance of a Chartered Structural Engineer.

#### 85 Application to Existing Systems

The studs may be formed in existing, but suitably modified pressed steel box lintels, to enhance the lateral stability of the otherwise empty section with fill; existing profiled metal flooring systems, used in conjunction with concrete topping, thus enabling these to be supplied to sites as precast units.

Standard Structural Hollow Steel sections, square, rectangular and circular can be similarly perforated and filled to enhance their load carrying capacity.

#### Description of Figures on Drawings

Fig. 1 shows typical steel ENBACIC wall/lintel/beam unit shutter, shown here as a 223mm high, 100mm wide, and of any length; its cross-section, typical distribution of perforations (a), with studs (b), and links (c). The studs and links may facilitate automatic provision of minimum cover to any additional reinforcement placed inside.

The recesses (d) may be used for, say, embedment of conventional wall ties.

An optional typical tie strip (e) is shown in position to restrain the shutter walls from bulging during the process of filling. The ends of the tie strips can be bent flat against the shutter as shown.

Fig. 2 shows an optional and typical stop-end plate (a) (also shown dotted in position on Fig. 1) with stiffening slits (b) and hooks (c) enabling the plate to be attached to the studs in the shutter.

Fig. 3 shows typical ENBACIC column shutter (a) with an ENBACIC splicing sleeve (b), 'kicker' (c) with the kicker-holding link strips (d).

The shutters may have any desired cross-section to suit the required cross-section of column, including hollow, the internal shutter of the latter having reverse projections of studs. The

kicker legs (c) may be perforated or otherwise deformed for bonding with the fill.

Fig. 4 shows a typical ENBACIC shutter for a floor slab unit. The sides of the shutter may be suitably deformed to key-in with similar adjoining units.

#### Mode of Carrying Out Invention

It is envisaged that the material mostly used will be of thin sheet steel, galvanised or protected otherwise subsequent to the manufacture of the completed shutter units, and mass produced in suitable standard lengths.

In buildings with the walls consisting entirely of ENBACIC wall units (Fig. 1) above the damp proof course, the wall shutters may be laid horizontally and filled; then followed by successive courses of horizontally laid and filled shutters, as in conventional brickwork or blockwork construction.

Odd lengths may be incorporated and the joints staggered in courses. Wall shutters may be used vertically, within the wall thickness, as vertical stiffeners, or piers, and filled as wall building proceeds. Conventional wall ties may be inserted to tie the vertical stiffeners with the wall panel. Cavity wall ties may be inserted between the horizontal units, in recesses provided, to hold any external facing brickwork or cladding through cavity.

In buildings with walls of brick or block construction the ENBACIC wall units may be built in, horizontally or vertically, in the walls as stiffeners or stabilisers, as lintels and piers, along with brick or block laying by the bricklayers.

Additional reinforcement may be incorporated if necessary.

The ENBACIC column shutters (Fig. 3) may be placed over conventional starter reinforcement. Thereafter shutters may be infilled. Brick piers may be strengthened by providing a core of ENBACIC column shutter and filling it progressively with mortar or concrete. The splicing sleeve (Fig. 3b) with its pre-cut studs pressed into the perforations of the column shutters, locks the upper shutter with the lower. The 'kicker' (Fig. 3c) may be inserted into the column shutter as shown, and left projecting through the floor slab to enable a further column shutter to be centred over for a further storey.

Additional reinforcement may be incorporated if necessary.

The ENBACIC floor unit shutters (Fig. 4) may be used for precasting ENBACIC floor units using conventional or lightweight concrete or other suitable air entrained material.

The perforations may be used for the purposes of fixing false ceilings etc. Side perforations may be used for threading through transverse reinforcement, if necessary. The shutters may have additional reinforcement incorporated, if necessary, and be infilled in-situ, the shutter itself providing the basic reinforcement, or not, as the case may be for fire resisting requirements.

#### CLAIMS

1. A shutter suitable for use in producing building structures, comprising a panel having extending from at least one face thereof an array or other plurality of projections directed away from said face and each having anchor means to engage, in use, infill material disposed adjacent said face.

2. A shutter according to Claim 1, in which said anchor means is integral with the projection carrying it.

3. A shutter according to Claim 2, in which said anchor means is provided by an enlarged portion of said projection.

4. A shutter according to Claim 1, 2 or 3, in which the projections and anchor means have been formed by deformation of the panel.

5. A shutter according to Claim 4, in which the projections and anchor means have been formed by pressing from the panel.

6. A shutter according to Claim 5, in which said pressing has left in the panel an aperture corresponding in shape to that of the projection and anchor means pressed from it.

7. A shutter according to Claim 6, in which said aperture is of keyhole shape.

8. A panel according to any of the preceding claims, in which the panel is planar and rectangular.

9. A system comprising at least one member designated to be filled with suitable material and set out in the associated description which is planar or otherwise and comprising plurality of bonding formations each formation comprising a perforation and projection of sheet metal or other material with enlarged projecting end, the other end being integral or attached to the remainder of the member, and the projection being the result of perforating the material, or otherwise and subsequently inwardly or outwardly, or both, bent out of the plane of the remainder of the material, according to the function of the member in the structure. The disposition of the projections being such as to provide automatically an amount of cover to any additional reinforcement rods placed thereon, the sizes of the perforations being such as to permit insertion of any additional known reinforcement rods or preventing excessive loss of a suitable infilling material.

10. A member according to Claim 9, and including a box section with two opposing sides comprising opposing C-shaping elements suitably spaced apart, having the said bonding formations and having top and bottom flanges rigidly jointed at intervals across the spacing.

11. A member according to Claim 10 having deformations in top and bottom flanges, at intervals to accommodate fixings between members, e.g. known wall ties.

12. A member according to Claim 10 or Claim 11 wherein the rigid connections of flanges across the space comprise links of angular cross-section with one leg projecting inwardly to facilitate automatic cover to any additional reinforcement placed thereon.

13. A member according to Claim 10, to and including Claim 12, wherein the sides are restrained from bulging with optional ties comprising suitable material, recessed at ends to lock the sides of the members through insertion into the said perforations.

14. A member according to Claim 10, to and including Claim 13, wherein the ends are closed with optional stop end plates of suitable material comprising stiffening slits and integral hooks locking on to the projecting bonding formations.

15. A permanent column shutter according to Claim 9 comprising a known standard hollow section with the said bonding formation, or a single or plurality of sheets with the said bonding formations to form a box of any cross-section by bending a suitable sheet, locking one sheet to another through the insertion of the bonding projections of one into the perforations of the other, or other known processes.

16. A member according to Claim 15 wherein one length of shutter may be extended with another or contain a 'kicker'.

17. A 'kicker' comprising a plurality of metal elements of angular cross-section and of suitable equal lengths with or without said bonding formations according to Claim 9, rigidly connected by a metal collar or collars at or near mid length, and the assembly inserted into the said column shutter, according to Claim 16, up to the said collar.

18. A floor/roof shutter according to Claim 9 wherein one side has a recess and the opposite side has a projection for keying with neighbouring unit, and having at least a portion of the said bonding formations according to Claim 9.

19. System or members substantially as herein before described with reference to and as illustrated in the accompanying drawings.

20. System of members having any novel feature or combination of features set out in the associated description.

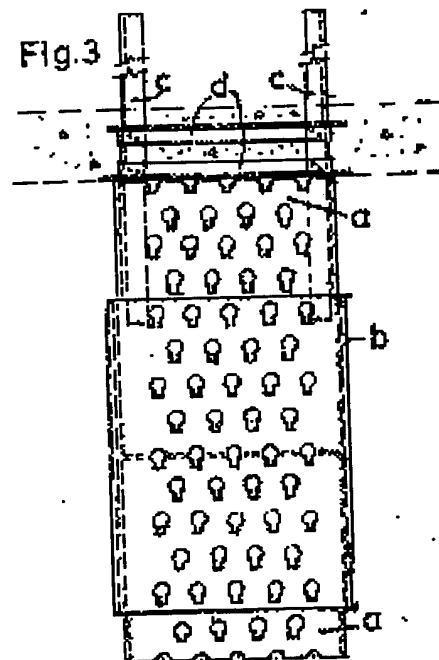
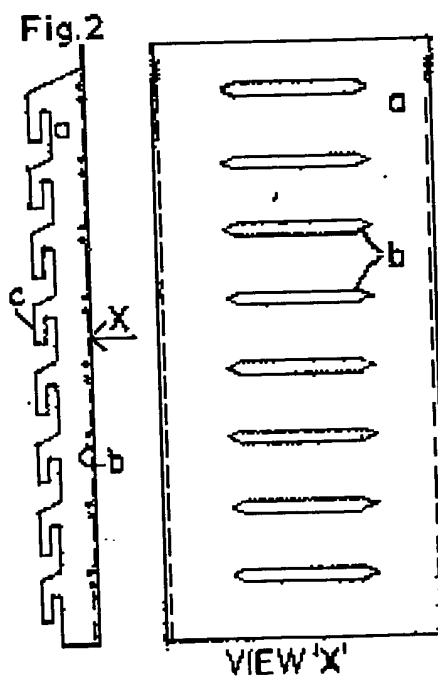
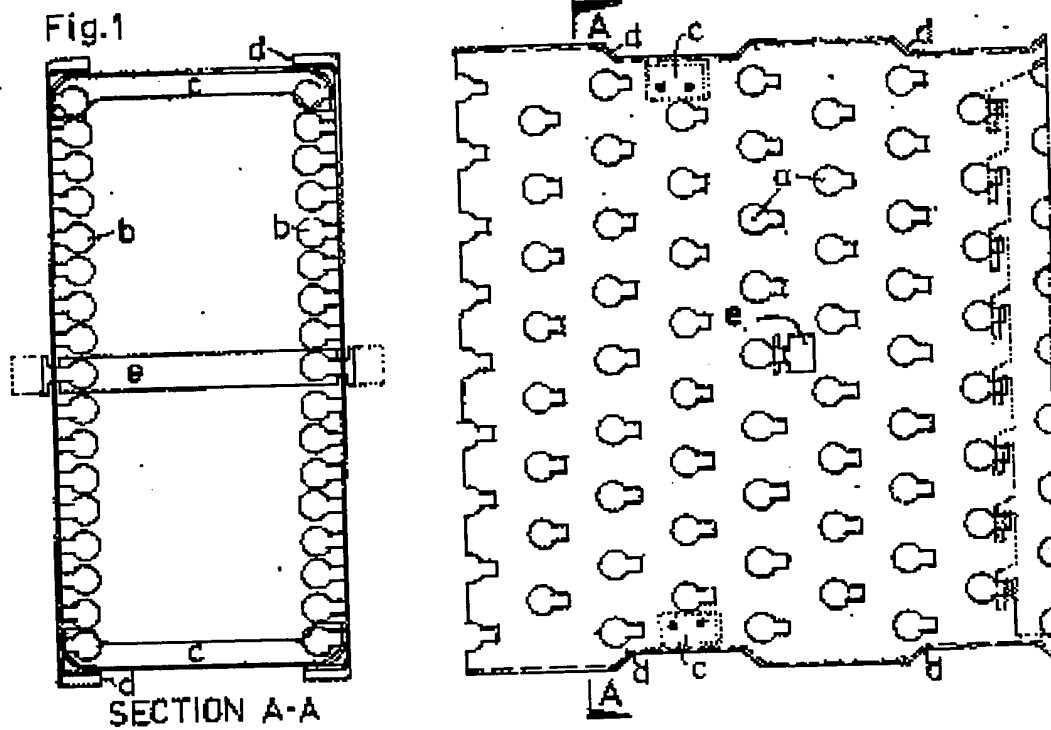
21. A shutter according to Claim 1, substantially as described herein with reference to the accompanying drawings.

22. A shutter suitable for use in producing building structures, substantially as described herein and substantially as shown in Figures 1 and 2 of the accompanying drawings.

23. A shutter suitable for use in producing building structures, substantially as described herein and substantially as shown in Figure 4 of the accompanying drawings.

24. Shuttering in the form of a hollow receptacle for infill building material, said shuttering comprising a plurality of walls at least one of which is a shutter as claimed in any of Claims 1 to 8 and 21 to 23.

25. A constructional unit comprising shuttering as claimed in Claim 24 containing infill building material.



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